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TITLE: PREPARATION OF SOIL ACTIVATOR CONSISTING MAINLY OF SOIL ACTIVE BACTERIA AND FUNGI

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ABSTRACT:

PURPOSE: To obtain a soil activator capable of promoting the decomposition and decay of organic substances with certainty and naturally, by forming a solid from cultured soil active, bacteria or fungi, specific minor nutrients and an extender cerrier.

CONSTITUTION: Soil active bacteria or fungi to take part in the decomposition and decay of organic substances are cultured, and specific minor nutrients, e.g. organic nitrogen sources, vitamins, and minor growth factors, taken in by the bacteria or fungi are added. Limes tone powder, vermiculite, perlite, zeolite, diatomaceous earth, or basic rock powder is incorporated as an extender solid to form a solid. Anaerobes or facultative anaerobes, e.g. thermophilic fibrinolytic or pectic bacteria, or aerobes, e.g. actinomycetes, molds, yeast-like fungi, kay bacilli, etc. may be cited as the bacteria or fungi.

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（全 10 頁）

㊹土壌有効菌を主体とする土壌活性剤の製造法

㉑特　　願　昭53—111873
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明　細　書

1. 発明の名称　土壌有効菌を主体とする土壌活性剤の製造法

2. 特許請求の範囲

1) 有機性物質の分解腐植化に関与する土壌有効菌を培養した後、これらの菌の要求する有機性窒素源、ビタミン類、微量生育因子等の特殊微量栄養素源を混和し、石灰岩粉、パーライト、バーミキュライト、ゼオライト、ケイ藻土、塩基性岩々粉等を増量担体として固型状とすることを特徴とする土壌活性剤の製造法。

2) 放線菌、糸状菌、酵母菌、枯草菌群細菌等の培養法を使用することを特徴とする特許請求の範囲第1項記載の土壌活性剤の製造法。

3. 発明の詳細な説明

本発明のいう土壌有効菌とは、土壌中に存在する、あるいは添加された動植物の遺体、または堆厩肥、コンポースト等の有機性物質の分解腐植化

(1)

にあたって主要な働きをする好熱性細菌を中心とした繊維素分解、ヘミセルロース分解菌、ペクチン質分解菌、紅色無硫黄細菌、放線菌、糸状菌、酵母菌、従属栄養細菌（枯草菌群細菌）のことで、本発明は、これらの菌を培養して種菌とし、その保存と散布、とくに土壌中における増殖と活動を活発にして、有機性物質を自然に、そして迅速、かつ確実な醗酵・腐植化をはかり、同時に散布される増量担体によって土壌の理・化学性を改善、強化するとともに、生物的活性度の高い土壌を作りあげる方法に関するものである。

戦後、日本の耕地は、多量の化学肥料と農薬の使用によって生産がいちじるしく向上したが、その反面、人間生活と自然環境の破壊、農薬公害、土の荒廃がおこる。土壌の荒廃は、有益な土壌微生物から空気、水分、栄養分、温度およびすみかを奪い、肥沃な耕地が不毛と化し、土壌を死の世界へと追いやる、その微生物の死滅は当然の結果

(2)

である。

肥沃な土壌、あるいはゆたかな地力とは、良質の有機性物質の施用と堆積によって土壌微生物の活動を促して、真正腐植を理・化学的に、また生物的に安定した物質として土壌中に集積していくことで、肥沃の根源は土壌中の腐植である。腐植は、有機窒素に富み、植物の栄養分である陽イオンの吸着保持、キレート作用、土壌の団粒化、そして、微生物活性を促すなど農業上きわめて重要な物質で、土壌の理・化学性は、土壌微生物性に深くかかわっている。

肥沃な土壌1gに細菌が100万から1000万個、また細菌、糸状菌、放線菌などの生体新鮮重量が10アール当たり300～500Kgといわれ、無数という形容があてはまる沢山の微生物が生棲している。これらもろもろの能力をもった微生物が生命活動を維持するため、種々様々な働きをいとなんでいる。こうした微生物の微妙な働きを考えると「土

は生きている」とは、まさに至言で、もちろん、土壌そのものに生命があるということではない。土壌中の多彩な小さな生き物のいとなむ生化学的変化に着目してのことで、土壌が1個の生体と同じようにさまざまな物質を化学的に変化させる多様で、力強い能力をもっている。この物質変化は、生体によっておこる化学反応であるから生化学的変化といい、その変化の能力、あるいはその大小の程度を土壌活性とよんでいる。すなわち、土壌活性は微生物に由来することがはなはだ大である。

また、土壌はたんなる岩石の風化物ではない。土壌は、物質循環の自然法則にしたがって、岩石の風化物と有機性物質を材料とし、微生物が長い年月をかけてつくりあげた「自然の創造物」で、しかも、つねに変化し、動いている。どの土壌にも歴史があり、生成・発展、栄枯・盛衰がある。まるで土壌自体がひとつの生命、ひとつの社会であるかのように機能する。そして微生物は前二者

とともに土壌の重要な構成要員であり、土壌の盛衰を支えるかなめでもある。

したがって、本発明の目的は、好熱性繊維素分解菌、ヘミセルロース分解菌、ペクチン質分解菌、紅色無硫黄細菌、放線菌、糸状菌、酵母菌、従属栄養細菌（枯草菌群細菌）等の有機質性物質の腐植・肥沃化に関与する微生物を人為的にし、これを種菌として積極的に土壌中に散布、増殖して、その密度を高め、有機性物質の分解・腐植化をより確実に、かつ自然に、しかもより促進しようとするものである。なおこの際、本活性剤に増量担体として配合された石灰岩々粉、バーミキュライト、その他の環境調整剤と特殊な微量栄養素源は、微生物のすみかとしての土壌環境と生育の諸条件をととのえ、人為的に土壌生態系のサクセション（遷移）と微生物相のバランスをたもって、土壌有効菌の増殖と作用をより効果的にする絶対に必要な条件である。

つぎに本発明の構成は、①好熱性繊維素分解菌、ヘミセルロース分解菌、ペクチン質分解菌、および紅色無硫黄細菌等の嫌気性または通性嫌気性菌の培養、②放線菌、糸状菌および酵母菌、従属栄養細菌（枯草菌群細菌）のような好気性菌の培養、③特殊有機性窒素源、ビタミン類および微量生育因子の添加、④石灰岩々粉とパーライト、バーミキュライト、その他の資材との混和による増量担体の調製、⑤前項各資材の混和による本発明土壌活性剤の製造。という5段階の製造工程からできている。

なかでも、本発明のとくに強調したい新規の構想は、①本発明者らの研究によって好熱性繊維素分解菌の集殖・連続培養を半永久的なものにすることができたこと、および放線菌や糸状菌の培養日数を短縮し、より多くの胞子の着生に成功したこと等によって、有機性物質の分解腐植化に関与する強力な微生物42株以上を種菌とすることがで

きた。②増量担体は、石灰岩々　のほかに、パーライト、バーミキュライト、ゼオライト、その他の土壌の理・化学的性質を改　し、　るいは土壌細境条件をととのえることに特異性を有する有益な資材は混合利用する。③現在まで知られている土壌微生物の要求する微量栄養素は、できるだけ沢山の種類を量的にもじゅうぶんにこたえられるように添加したことである。

1. 好熱性繊維素分解菌等の通性嫌気性または嫌気性菌の培養

①好熱性繊維素分解菌の培養

繊維素は自然界にもっとも広く、かつ多量に分布している。細胞壁を形成して木材、ワラ類等にとくに多く、またほとんどすべての植物性有機性物質中に含まれている。したがって土壌に還元されて腐植化される場合の分解経路および関与する微生物の機能や生態などは、もっとも基本的な研究課題のひとつである。繊維素分解菌と総称され

るなかには、細菌、放線菌および糸状菌等の種類が含まれるが、しかし、繊維素分解力の旺盛な点、幅広い繁殖条件などの点から有機性物質の分解熟成にクロストリデーム（Orostridium）サーモセルム（thermocellum）、バチルス（Bacillus）サーモセルロリチクス（thermocellulolyticus）、バチルス（Bacillus）サーモフィブリンコルス（thermo－fibrincolus）、バチルス セルローゼ デソルベンス（Bacillus cellulosae dissolvens.）等の好熱性細菌が重要な役割をはたす。

好熱性繊維素分解菌の培養はViljoen.Fred.Peterson（1926）の培地：ペプトン5g、炭酸カルシウム過剰、リン酸水素アンモニウムナトリウム2g、リン酸二水素カリウム1g、硫酸マグネシウム0.3g、塩化カルシウム1g、塩化第二鉄痕跡、繊維素（ろ紙）15g、井水1,000cc。を使用する。この培地組成の一部を天然物におきかえてもよい。60±5℃、嫌気的あるいは通性嫌気的条件下で

48〜60時間培養する。

②ヘミセルロース分解菌の培養

繊維素とともに植物体（細胞壁）を形成しているが、希塩基および希酸に容易に溶解する性質等によって繊維素と区別される。加水分解するとそれぞれ構成する糖類、たとえばキシロース、アラビノース、グルコース、マンノース、ガラクトース等を生成する。ヘミセルロースはこれらの成分にしたがってキシラン、アラバン、デキストラン、マンナン、ガラクタンと称せられる。

なかでもキシランは繊維素、デンプンに次いで自然界に広く、かつ多量に存在する炭水化物であって、とくにワラ類、木材、種皮などに多い。

ヘミセルロース分解菌の培養液中にイナワラキシランを約1%濃度に溶かした岩田の培地（1936）：リン酸二水素アンモニウム1g、塩化カリウム0.2g、硫酸マグネシウム結晶0.2g、水酸化ナトリウム0.1N液40cc、井水960cc、PH6.8〜7.0を使

用する。35±3℃、通性嫌気的に集積する。

③ペクチン質分解菌の培養

ヒドロペクチンはもちろん、プロトペクチンから低分子のペクチン酸まで鎖状に結合したD−ガラクツロン酸を主体とするものを一括してペクチン質（Pectic Substance）といい、茎葉、根芋、果実等に多量に含まれている。

ペクチン物質を強力に分解する細菌は、好気性のものでは枯草菌群およびエタノール・アセトン菌に、嫌気性のものでは酪酸菌に属するものが多い。本発明ではMolisch（1939）の処法による培地：ペクチン（レモンまたはニンジンより抽出）0.5g、リン酸二水素カリウム0.05g、硫酸アンモニヤ0.05g、炭酸カルシウム0.2g、水道水100cc。を使用し、35±3℃、で集積する。

④紅色無硫黄細菌の培養

光合成細菌は、紅色硫黄細菌、緑色硫黄細菌および紅色無硫黄細菌の3科に分類され、それぞれ

13属、6属、2属にわけられている。本発明で主として使用する細菌は紅色無硫黄細菌で、本菌のもつ優れた性質、すなわち有機性物質の分解によって生ずる低分子の有機酸、アミノ酸、アルコール類等を好んで資化し、硫化水素を分解し、空気中の窒素を固定する能力等を積極的に活用する。

紅色無硫黄細菌の培養はHutner (1946)の培地：K_2HPO_4 0.05(%)、KH_2PO_4 0.05(%)、$(NH_4)_2HPO_4$ 0.08(〃) $MgSO_4$ 0.02(〃)、乳酸 0.5(〃)、酪酸 0.1(〃)、クエン酸 0.1(〃)、Fe 200(γ%)、Ca 500(〃)、B 5(〃)、Cu 1(〃)、Mn 100(〃)、Zn 200(〃)、Ga 1(〃)、Co 1(〃)、Mo 5(〃)、以上の成分を蒸留水に溶解し、さらにその1000 ccにビオチン13.7 ug、酵母自己消化物600 mgを添加し、PHを6.8～8.5に調整。を基本培地として使用する。その時の状況に応じて天然物に一部代替する。25±7℃、好気的または嫌気的、明（光）または暗（光）の条件下で、48～72時間培養する。

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⑤上記の通性嫌気性または嫌気性菌の量産

一部天然物に代　することも　るが、それぞれの単離または集積用培地を使用する。好熱性繊維素分解菌には単段連続発酵方式により、またヘミセルロース分解菌、ペクチン質分解菌および紅色無硫黄細菌は多段循環型連続発酵方式によって、800～1000 ℓ/日、通性嫌気的または嫌気的に多量培養する。

2　放線菌等の好気性菌の培養

①放線菌の培養

放線菌（Actinomycetales）は自然界に広く分布しており、とくに土壌中には、多種、かつ多数の放線菌が検出される。なかでも、好気性、中温性、ヘテロトローフ、腐生性、好中性のグループに属するものがその中心をなしている。

土壌中の働きについて一般的に言うことがむずかしい。各種有機性物質、とくに難分解性のセルロース、リグニン等を分解し、土壌肥沃のもとに

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なる腐植の生成に他の微生物とともに重要な働きをしており、また抗生物質の生産を通じてのミクロフロラ・コントロールの面で重要な意義をもつものとみられる。

放線菌の培養はWaksman (1919)の培地：シュ糖30g、硝酸ナトリウム2g、リン酸水素二カリウム1g、硫酸マグネシウム（$MgSO_4 \cdot 7H_2O$）0.5g、塩化カリウム0.5g、硫酸第一鉄（$FeSO_4 \cdot 7H_2O$）0.01g、水1000 cc、PH 7.0に調整。を使用し、土壌中または堆肥中より強力菌を集積する。

②糸状菌および酵母菌の培養

便宜上または実用上糸状菌（Soil Fungi.molds）と酵母菌（Soil Yeasts）に大別されるが、系統分類学上、ともに真正菌（Eumycetes）に属する。すべて有機（従属）栄養であり、炭素源として有機性物質を利用している。

この糸状菌のもっとも多く存在する場所は細菌、放線菌と同様土壌で、土壌中の糸状菌は当然植物

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根のある作土に多く、とくに根圏ではその働きも活発である。植物遺体などの有機性物質の分解にあずかり、土壌の肥沃度に関係する。糸状菌は主として分解の初期段階に活動していると考えられ、細菌、放線菌とサクセションが進む。

つぎに酵母菌の土壌中における働きについては不明な点が多いが、しかし、土壌中に相当数の酵母菌が存在し、かつその保有する微量生長因子をめぐって他微生物との共存、共栄や土壌活性など将来の研究に期待されることが大きい。

糸状菌および酵母菌の培養にCzapek of Dox（1910）の培地：硝酸ナトリウム2g、リン酸水素二カリウム1g、塩化カリウム0.5g、硫酸マグネシウム（$MgSO_4 \cdot 7H_2O$）0.5g、硫酸第一鉄（$FeSO_4 \cdot 7H_2O$）0.01g、シュ糖30g（適宜）、蒸留水1000 cc、固型培地には寒天15g添加。を使用し、糸状菌としてはムコール属（Mucorales）、アスペルギルス属（Aspergilli）、ペニシリウム属（Penicillia）

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トリコデルマ属(Trichoderma)等を、また酵母菌としてはハンゼヌラ属(Hansenula)、トルラ属(Torulopsis)、ピヒア属(Pichia)、エンドミセス属(Endomycopsis)、サッカロミセス属(Saccharomyces)等を土壌あるいは堆肥中より分離・培養する。

③従属栄養細菌(腐敗菌)の培養

糖類の分解も同様であるが、タンパク質を分解してアンモニアを生成する細菌の特定のものは稀であって、ほとんど細菌一般の通性となっている。本発明では枯草菌群細菌を利用する。一般に好気性、加熱に対してとくに抵抗力の強い胞子をもった細菌で、土壌、その他自然界にもっとも広く分布している多数の細菌を枯草菌群細菌と総称している。

枯草菌群細菌の培養は、Waksman (1922) の培地:ブドウ糖1g、リン酸水素二カリウム0.5g、硫酸マグネシウム($MgSO_4 \cdot 7H_2O$) 0.2g、硫酸第二鉄($Fe_2(SO_4)_3 \cdot 9H_2O$)痕跡、卵白(粉末)0.25g、蒸留水1000cc、PH 7.2。を使用して本菌群を好気的に集殖する。

④上記好気性菌の量産

原液を調製、殺菌した後、単離または集殖培養した上記好気性菌をそれぞれ接種して、高度通気下の深部培養または振盪培養する。300〜500ℓ/日単段連続発酵方式をとる。

そして、放線菌および糸状菌については、これらの培養液を3〜10倍に希釈し、栄養源を追加して、パーライト、バーミキュライト等の軽量、多孔質の担体に散布、よく混和し、大型シャレー積み重ね方式、または堆積型の回分式(Batchwise)培養を行なう。3,000〜5,000kg/日、通気、温度、湿度等を菌体の増殖と胞子着生の最適条件に自動的に調整して72〜85時間培養する。

このときの配合比は、一般に増量・担体100に対して25〜45の割合(重量比)で、その適量はその種類、とくに吸水性によって実験的に決める。

3. 特殊有機性窒素源、ビタミン類および微量成育因子の添加

水田でも、畑地でも同様であるが、良質の耕作土中には $X10^7 \sim 10^9/g$ という驚くべき数の細菌が存在する。そのなかで糖と無機塩類だけで生育できるのは15%に満たない。大部分の細菌は何んらかの形でアミノ酸、ビタミン類、VGF(未知の生長因子)等の微量成育因子を要求する。好熱性繊維素分解菌も、紅色無硫黄細菌もまたその例外ではない。もし、これらが欠除した場合、好熱性繊維素分解菌の連続培養が不可能になり、また、紅色無硫黄細菌では増殖が停止して異常発酵をおこす。

そこで、前者の微量生育因子をVGF−α、後者では、VGF−β(別名グロスター)とする。これらは本発明者たちが、新規に発見したものであって、VGF−αは40ppm以上、VGF−βは0.5ppm以上をそれぞれの培養に使用する。

また、まえに述べたような理由によって一般の土壌有効菌のために下記のような微量栄養素を本発明の土壌活性剤中に添加する。

ビタミンB_1(チアミン)	1.00 ppm 以上
〃 B_2(リボフラビン)	5.00 〃
ニコチン酸	8.00 〃
ビタミンB_6(ピリドキシン)	0.40 〃
パントテン酸	4.00 〃
葉酸	0.20 〃
コリン	1.00 〃
ビオチン	0.20 〃
ビタミンB_{12}(コバラミン)	0.05 〃
パラアミノ安息香酸	5.00 〃

コーンスチップリカ(CSL)	0.01% 以上
脱脂大豆塩酸加水分解物	0.05 〃

4. 増量担体の調製

今、田畑に散布する有効菌は、土壌に比していちじるしく微量であるから、これを均等に散布することがきわめて困難である。このため、増量担体を必要とする。

増量担体として石灰岩々粉（ドロマイト岩粉）のほかにパーライト、バーミキュライト、ゼオライト、ケイ藻土、ボーキサイト等の土壌の理学的、化学的または生物的機能が改善され、あるいは土壌環境条件をととのえることなどに特徴を有するものは資材として利用する。

そして、パーライト、バーミキュライト、ゼオライト等の軽量、多孔質、水分吸着性などに着目して、その一部を糸状菌および放線菌の菌体の増殖と胞子着生のための好気的培養に使用する。このような無機質の資材は、1000℃前後の焼成または苛酷な化学処理を受けるため実用上無菌とみなされ、他の有害菌および雑草の種子の混入の恐れがない。

次ぎにおもな増量担体の成分表を示し、それらの特徴について述べる。

おもな増量・担体の成分表

項目		パーライト	バーミキュライト	ゼオライト（合成）	ケイ藻土
ケイ酸	SiO_2	74.55	44.06	43.94	92.16
鉄	Fe_2O_3	0.71	15.26	1.67	0.94
アルミナ	Al_2O_3	15.43	15.52	27.33	2.01
石灰	CaO	0.48	2.05	0.53	0.46
苦土	MgO	0.92	6.61	0.79	0.94
リン酸	P_2O_5	0.25	0.07	0.11	0.07
ソーダ	Na_2O	2.05	0.16	10.49	0.17
加里	K_2O	4.41	3.82	0.15	0.61

項目		玄武岩々粉	カンラン石玄武岩々粉	石灰岩々粉
ケイ酸	SiO_2	51.05	46.90	0.10
鉄	Fe_2O_3	6.42	4.32	0.02
アルミナ	Al_2O_3	13.61	11.46	0.02
石灰	CaO	10.07	9.02	54.40
苦土	MgO	5.43	14.47	2.92
リン酸	P_2O_5	0.50	0.17	0.04
ソーダ	Na_2O	2.05	1.83	0.05
加里	K_2O	1.50	1.02	0.43

(1) パーライト

黒曜石、真珠岩、松脂岩やこれらの凝灰岩などを急激に1,000℃前後で焼成し、多孔質にしたもので、かさ比重0.4～0.6、極めて軽い雪白の粒子である。それに水分の吸着性がきわめて大きく、重量で350～400％という大量の培地を吸着し、好気性菌のすぐれたすみかをつくる。

また、水分を吸着しても軟化して崩るということがなく、土壌に混ぜた場合、粘度粒子が表面に付着してもその働が妨げられることがない。つねに最大の通気性を保ち、混じた土壌の物理性を改良する。

パーライトの酸度はPH 7.0～7.5で、前記通気性と相俟って吸着後の菌の繁殖を助長し、かつ土壌酸性を緩和しうる特性がある。さらに重要なことは、パーライトが無数の閉ざされた空気細胞からできているので優秀な断熱効果を示し、土壌の極端な温度変化と水分の急激な蒸発を防ぎ、引いては植物根圏の微気象を改善し、かつ土壌微生物の繁殖ならびに栽培植物の正常な発育を助長する。そして、パーライトは、軽量、無臭、不燃性であるから、貯蔵、輸送、取り扱いが安全であり、便利である。

(2) バーミキュライト

選別した蛭石（Vermiculite）を乾燥後、1000℃前後で焼成したものを普通バーミキュライトと呼んでいる。

前記成分表は、その一例で、パーライトと同様バーミキュライト自体にカリウムの含有量が多い。そして、バーミキュライトの気孔率の高いのが特徴で、水分吸収や、保水力に優れ、排水や空気の流通がよく、これを施用した場合、土壌団粒構造がよく発達するので高度化した微生物のすみかが豊富にできる。

また、バーミキュライトはいちじるしく強力な塩基の置換性をもっているので、肥料もちがよく、

過剰肥料のコントロールに勝れた能力を示す。たとえば、加里過剰による苦土欠乏症の防止に特異的効果をみせる。なお、園芸用とした場合、栽培植物の発根が旺盛で、毛根ががっちりとバーミキュライトのなかにはいり込むので植えいたみが少くない。

(3) ゼオライト

加熱するとブツブツと沸騰するように脱水するので一名沸石ともいわれる。ゼオライトは、化学組成からアルカリまたはアルカリ土類金属の含水アミノ珪酸塩で、無限に広がる三次元網目構造をもつ framework silicate 群と定義される。一般式は（Na_2、K_2、Ca、Ba）〔（Al、Si）O_2〕n・xH_2Oと書かれ、水分が連続的に脱水して、その一部が可逆的に復水するが、加熱脱水後、多孔質の吸着媒、または分子ふるいとして利用すること、アルカリおよびアルカリ土類金属は高い交換性をもつことを、もっとも重要な特徴とする。

ゼオライトは、天然に広く産出するにもかかわらず、工業的利用という見地からみると、Linde社（米国）の合成ゼオライト"モレキュラーシーブ"が圧倒的地位を占める。天然ゼオライトの色はさまざまなものが見られるが、粉砕により容易に白色化する。そのおもな用途は製紙用、プラスティック用充填剤、洗剤混合用などに使用されるが、上記特性のほかに触媒作用等も有するので、これらの特徴を総合的にとらえて、畜産、養鶏の厩の脱臭、乾燥、屎水処理、土壌改良剤としても利用されている。

なお、成分表には、天然物から化学的に作られた合成ゼオライトの一例を示した。

(4) ケイ藻土

ケイ藻土は、ケイ藻と呼ばれている過去の地質時代にさかんに繁殖した非常に小さな藻の化石からできている軟質岩石または土壌である。採掘原土を、さらに選別し、水洗、乾燥して、そのまま粉砕処理して製品とするか、乾燥後、焼成してから製品とする。

ケイ藻土の主成分はケイ酸で、真比重は 210 ～ 226 で、純ケイ酸の比重とほとんど変らないが、構造上、ケイ藻殻中に空間を閉じ込めてあるため、気孔率 80 ～ 90 %、極めて多孔質で見掛比重が0.22 ～ 0.28といちじるしく軽く、単位重量当たり大きな容積をもっていること、ことに高度の液体吸収性があって、約3倍重量の水を吸収、保持すること等の物理的特性をもっており、また化学的にもわずかにフッ化水素酸、強アルカリ液に犯されるほか、ケイ藻土自体はほとんど変化をうけない特性をもっている。また、ケイ藻土は、粉体の肥料等に3～5%混和したとき、流動性がよくなり、固まりができないという特性があって増量材としてすぐれているほか、保温性があって、植物根圏の微気象を改善するに役立つ。

(5) 玄武岩

玄武岩とは、塩基性火山岩の総称で、広義には超塩基性岩も含むこともあるが、本発明では、ソレイアイト質玄武岩、カンラン石玄武岩、カンラン岩、ヘンレイ岩等の塩基性岩または超塩基性岩の岩粉を利用しようとするものである。

理由は、本発明者たちが、成分表に示されるように、これらの岩石自体にマグネシウム、カルシウムの含有量が多く、細粒化が進む程水素イオン濃度が上昇し、容易に PH11.6 ～ 12.0 になることを実験的に確認し、酸性土壌の改善に役立つことを知った。そして、これらの岩粉は、砕石場の廃捨物として年間数万トン以上得られるので、本発明の増量担体として使用する。

(6) 石灰岩（ドロマイト）岩粉

成分表に見られるとおり、容易に溶出するカルシウムおよびマグネシウム・イオンが主成分で、栽培植物や好熱性繊維素分解菌をはじめ土壌有効菌の栄養源となるばかりでなく、土壌水素イオン

湿度の調整や土壌団粒構造の造成、その他土壌中のリン酸を有効化し、非置換性のカリウムを解放し、鉱害地における重金属の害を除くなど、良好な環境条件を作るのに役立つ。

5. 土壌活性剤の製造

最後に、増量担体のもうひとつの大きな役目は、土壌活性剤全体の水分を7%以下におさえこんで、外気温や湿度による影響を防ぎ、胞子や耐久細胞として半休眠状態にある土壌有効菌が変質することなく、長期間保存することである。

以上のようにして、石灰岩々粉をはじめ、各増量担体の特性と、耕地の利用法、土壌の理・化学的性質や生物的活性度、あるいは栽培植物の種類などに応じて、石灰岩々粉に対して5%から7%まで、他の各増量担体の配合割合と、さらに散布器機の種類や型式などによって各増量担体の粒度を決め、最終的に有害菌の汚染、種菌劣化防止、保存、から生産管理等の経済性まで考慮し、総合的な判断の下に粉末状、ペリワト状、パール状、フレーク状　、土壌活性剤の形態　決定する。

そこで本発明は、前記のとおり土壌中の有機性物質の分解腐植化に役立つ主要菌、すなわち好熱性繊維素分解菌、ヘミセルロース分解菌、ペクチン質分解菌、紅色無硫黄細菌等の嫌気的培養または通性嫌気的培養に、それぞれ適合する天然高分子凝集剤（荷電移動体）を加えて得られる濃厚菌体液、酵母菌や従属栄養細菌（腐敗菌）の好気的培養の前記同様の濃厚菌体液、および糸状菌、放線菌の固体状、好気的培養を培地とともに、さらに有機性窒素源、ビタミン類、微量生育因子等を石灰岩々粉を主体とした増量担体に加えて、よく攪拌混合し、決定された形態の製品とする。

原材料配合の一例は下記のとおりである。

原材料の配合割合

（石灰岩々粉 1,000.0 g に対して）

好熱性繊維素分解菌の濃厚菌体液	0.3 g
ヘミセルロース分解菌の濃厚菌体液	0.3 g
ペクチン物質分解菌の濃厚菌体液	0.3 g
紅色無硫黄細菌の濃厚菌体液	0.5 g
糸状菌の固体培養	50.0 g
放線菌の固体培養	50.0 g
酵母菌の濃厚菌体液	0.7 g
従属栄養細菌の濃厚菌体液	0.3 g
VGP − α	50.0 mg
VGP − β（別名グロスター）	20.0 mg
ルチン	10.0 mg
ビタミン B_1	1.2 mg
ビタミン B_2	5.5 mg
ニコチン酸	800.0 mg
ビタミン B_6	0.5 mg
パントテン酸	400.0 mg
葉酸	0.3 mg
コリン	15.0 mg
ビオチン	0.2 mg
ビタミン B_{12}	0.1 mg
パラアミノ安息香酸	7.0 mg
コーンスチップリカ（CSL）	0.5 g
脱脂大豆塩酸加水分解液	0.7 g
パーライト（糸状菌、放線菌の培養用）	100.0 g
ケイ藻土	30.0 g
バーミキュライト	200.0 g
石灰岩々粉	1,000.0 g

このようにして、本発明のすぐれた効果として、つぎのような利点を挙げることができる。

(1) 土壌糸状菌、放線菌等の好気的固体多量培養法の新規開発と、VGP − α および VGP − β（別名グロスター）の本発明者らの発見によって好熱性繊維素分解菌の連続培養や紅色無硫黄細菌の異発酵の防止によって、これらの多量培養法を新たに考案し、主要細菌とみなされる42株以上の種菌

を含有する土壌活性剤の製造に成功した。そこで、本土壌活性剤を積極的に散布、増殖して、人為的にその密度を高め、土壌生態系のサクセッションと、微生物相のバランスを保って、土壌中の有機性物質の真性腐植質化が、より確実に、より迅速に、かつ自然に進めることのできることは、現在、日本農業の「土つくり」に対して、はなはだ有効なひとつの方法である。

(2) コーンスチップリカ(CSL)脱脂大豆塩酸加水分解物等の特殊有機性窒素源、ビタミン類、VGF－α、VGF－β(別名グロスター)等の微量生育因子の添加および、酵母菌や紅色無硫黄細菌の接種、増殖は、広く一般土壌微生物の生育に好影響を与え、上記(1)の利点がより効果的なものとなる。

(3) 石灰岩々粉の主成分は、カルシウムおよびマグネシウムイオンで、微生物や栽培植物の必須の栄養源となるほか、同時に土壌の理・化学的または生物的機能が改 され、あるいは環境条件がととのえられ、団粒構造の形成が助長され、リン酸の固定化を防止して火山灰地の肥効を増進する等、間接的肥料としての効果も示す。

(4) 本発明のような土壌有効菌の人工接種法が成功するか、否かは、それらの菌が定着し、活動する条件がつくられるか、どうかにかかるが、増量担体として石灰岩々粉とともに多量に散布される。パーライト、バーミキュライト等は、軽量、多孔性で排水、通気性がよく、また水分吸収、保水性が大である。それぞれ塩基置換性がすぐれ、水素イオン濃度を調整し、団粒構造の造成を助長して、高度化した微生物のすみかば豊富につくる。

(5) 本発明の増量担体は、無機質で化学的にも安定しているため、効果的な種菌の培養、さらに巨大な胞子、耐久細胞を含有する土壌活性剤は、変質することなく長期の保存にたえる。

(6) また、本土壌活性剤を固型状とし、粉末、ペリット、パール、フレック状と、その形態を選ぶことによって、その貯蔵と散布を容易、確実なものにする。

本発明による土壌活性剤を施用した実施例のいくつかでは、そのすばらしい効果をさらによく実証するものである。

実施例1

「土つくり」は、良質完熟堆肥の連年施用によってその目的が達せられる。堆肥は「土つくり」のための総合的効果の高い最高の資材である。本発明の土壌活性剤は、堆肥の熟成にもすばらしい効果を示す。

イネワラ 1,000 Kgに対して 80 Kgの粉末状土壌活性剤(パーライト：バーミキュライト：石灰岩々粉＝5：20：100)と水分を加えて、約8～10日間仮積する。つぎに窒素 12Kgに相当する硫安または尿素を散布し、適度に散水しながら軽くふみつけながら本積とする。途中一回切り返しを行なう。よく発酵し 45 日で完了する。じゅうぶんに腐熟し、全体が赤ぐろい色に変り、しっとりとして、ひっぱるとすぐくずれる状態となる。炭素率 18.2 を示す。

そして、本発明の土壌活性剤の代りに、パーライト：バーミキュライト：石灰岩々粉＝5：20：100の混合物 80Kgを加えたものと、無添加のものとを対照とし、土壌活性剤施用のものと全く同様にして平行実施した結果は、対照の前者は半熟の程度、後者はパサパサとして、まだ堆肥とは認められなかった。

なお、対照前者の炭素率は 33.6 、後者は 39.2 であった。

実施例2

水田における施用試験である。

試験圃場：秋田県横手市、山間部地帯で、山林

より 300 mはなれる。水田には 年10アール当り牛糞堆肥1100kg投入。土性は 通。

供試品種：キヨニシキ

試験規模：1区 10アール

試験条件：施用区に、4月27日、本発明の土壌活性剤（バーミキュライト：石灰岩々粉＝10：100）を100kg散布しただけで、施用区、対照区両者とも同じ条件で以下の肥培管理を行なった。

元　　肥：複合燐加安（2、8、4）40kg 5月6日。

耕　　起：5月7日

田　　植：5月22日

追　　肥：尿素4回18kg対照区だけに使用。

刈　　取：10月5日。

活着および初期生育では、施用、対照両区とも他の水田と変りなく順調であったが、6月後半の高温期に入ってから両者の差がはっきりと認められた。施用区のガス発生がきわめて少なく、稈、葉共ともに太く、長いため、徒長、青立倒伏の恐れから施用区だけ追肥を行なわなかった。それにもかかわらず、よく分けつし、強稈に生育して、出穂も5〜6日早く、倒伏もなかった。

試験結果は、刈取り10月14日、施用区の実収量776kg、対照区639kgで、約21%の増収であった。

実施例3

宮崎県のハウス栽培に対する施用試験である。

(1)トマト

昨年度、青枯れ病、根ぐされ病の発生した土地を選び施用した。ウネ作り前に10アール当り100kgの本発明のペリット状土壌改良剤を元肥の有機質肥料（野草や藁葉等を主とした3ヶ月あまりの堆積物）および配合肥料に混入して施用した。消毒、その他の肥培管理は通常どおり実施した。

前年度の青枯れ病および根くされ病が全然発生しなかった。

果実は鮮度がよく、色調も良好で、4%以上の増収となり、本発明の土壌活性剤の施用によって連作の可能であることがわかった。

(2)キュウリ

トマトと同じ施用を試みる。まったく発病がみられず見事に生育した。キュウリは、太く、長く、曲りがなく、よくそろって量も多く、30%以上の増収となった。また品質的にもすぐれ、他区の生産品より20%位高く販売できた。

本試験に施用した土壌活性剤の原料配合は、バーミキュライト：石灰岩々粉＝40：100。

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（ほか1名）

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METHOD FOR PREPARING SOIL ACTIVATOR CONSISTING MAINLY OF SOIL-ACTIVE BACTERIA AND FUNGI

[Dojo Yukokin wo Shutai Tosuru Dojo Kasseizai no Seizoho]

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SPECIFICATION /249*

1. Title

Method for Preparing Soil Activator Consisting Mainly of Soil Active Bacteria and Fungi

2. Claims

(1) A method for preparing a soil activator comprising cultivating soil active bacteria and fungi that are involved in decomposition and humification of organic matter, subsequently blending special micronutrient sources, such as organic nitrogen sources, vitamins, trace growth factors, etc., that these bacteria and fungi require, and forming the mixture into a solid, using limestone powder, perlite, vermiculite, zeolite, diatom earth, basic rock powder, etc., as the extender-carrier.

(2) The method for preparing a soil activator stated in Claim 1, wherein methods for cultivating actinomycetes, filamentous fungi, yeast fungi, bacteria of the Bacillus subtilis group, etc., are employed.

3. Detailed Description of the Invention

The soil-active bacteria and fungi mentioned in the present invention are cellulose-decomposing or hemicellulose-decomposing bacteria that are mostly thermophilic bacteria, pectinaceous substance-decomposing bacteria, purple non-sulfur bacteria,

* Number in the margin indicates pagination in the foreign text.

actinomycetes, filamentous fungi, yeast fungi, and heterotrophic bacteria (bacteria of the Bacillus subtilis group), which have a major function in decomposition and humification of such organic matter as animal and plant remains that are present in or added to the soil, manure, [illegible], or composts. The present invention pertains to a method according to which these microbes are cultivated to obtain seeds, which are preserved and disseminated in such a manner that their proliferation and activities in the soil are activated so as to bring about fermentation and humification of organic matter naturally, quickly, and reliably, and also according to which the extender-carriers, which are disseminated simultaneously with the microbes, improve and enhance the physical and chemical properties of the soil and also increase the degree of biological activity of the soil.

In the postwar era, the use of chemical fertilizers and agricultural chemicals in large quantities improved the yields of the agricultural lands in Japan remarkably, but it also brought about the destruction of the living environment for humans and of the natural environment, agricultural pollution, and deterioration of the soil. As the soil deteriorates, beneficial microbes are deprived of air, water, nutrients, temperature, and their habitats, and the fertile cultivated land becomes barren; thus, the soil is condemned to death. The death of the microbes in the soil is a natural result of it. /250

Fertile soil, or rich soil fertility, is the result of inducing the activity of soil microbes by the application of high-quality organic matter and deep tillage so as to accumulate true humus in the soil as a physically and chemically, as well as a biologically, stable substance; thus, the humus in the soil is the foundation of fertility. Humus is rich in organic nitrogen and has the function of absorbing, retaining, and chelating cations, which are plant nutrients, and also has the effects of, for example, forming a crumb structure in the soil and of inducing microbial activities, thus rendering itself a very important substance in agriculture, and the physical and chemical properties of the soil are deeply related to the soil microbial properties.

It is said that 1 g of fertile soil contains 1 million to 10 million microbes and that the fresh weight of such living organisms as bacteria, filamentous fungi, actinomycetes, etc., is 300 to 500 Kg per 10 ares; thus, numerous microorganisms, which can be better described by the adjective "countless," inhabit soil. These microorganisms with varieties of abilities carry out various kinds of work so as to sustain their life activities. When the delicate workings of these microbes are considered, "the soil is alive" is a true saying, but, of course, it does not mean that the soil per se has a life. It is referring to the biochemical changes brought about by assorted small creatures in the soil, and a mass of soil, like one living body, has

various strong abilities that cause various substances to undergo chemical changes. Since these substance changes are chemical reactions caused by living organisms, they are referred to as biochemical changes, and the abilities to bring about these changes or their degrees are referred to as soil activities. That is to say, soil activities are mostly derived from microorganisms.

Moreover, soil is not a simple efflorescence of rocks. Soil is a "handiwork of nature," which was created from rocks' efflorescence and organic matter by microorganisms over long periods of time according to the laws of nature regarding material recycling, and it is constantly changing and moving. Each soil has its own history and undergoes formation, growth, and rise and fall. The soil functions as if it were one life or one society. Microorganisms are an important constituent of the soil along with the aforesaid two components, and they are also the key factor for the rise and fall of the soil.

Accordingly, the objective of the present invention is to bring about and also promote the decomposition and humification of organic matter more reliably and naturally by artificially cultivating microorganisms, such as thermophilic cellulose-decomposing bacteria, hemicellulose-decomposing bacteria, pectinaceous substance-decomposing bacteria, purple non-sulfur bacteria, actinomycetes, filamentous fungi, yeast fungi, heterotrophic bacteria (bacteria of the Bacillus subtilis group), etc., which are involved in the humification and fertilization

of organic matter, and by actively disseminating and propagating them in the soil as seeds, thus increasing their concentration in the soil. Here, limestone powder, vermiculite, and other environment-adjusting agents, which are blended as the extender-carrier in the activator of the present invention, as well as special micronutrients are absolutely essential ingredients that improve the soil environment as the habitat of microorganisms and various growth conditions and that artificially maintain the succession of the soil ecosystem and a balance in the microorganism phases, thereby making the proliferation and actions of the soil active bacteria and fungi more effective.

The present invention is composed of the following five process steps: ① cultivation of anaerobes or facultative anaerobes, such as thermophilic cellulose-decomposing bacteria, hemicellulose-decomposing bacteria, pectinaceous substance-decomposing bacteria, purple non-sulfur bacteria, etc.; ② cultivation of aerobes, such as actinomycetes, filamentous fungi, yeast fungi, and heterotrophic bacteria (bacteria of the Bacillus subtilis group); ③ addition of special organic nitrogen sources, vitamins, and trace growth factors; ④ formulation of an extender-carrier by blending limestone powder with perlite, vermiculite, or other materials; and ⑤ formulation of the soil activator of the present invention by blending the aforesaid ingredients.

The novel concepts of the present invention that the inventors especially want to emphasize are as follows. ① As a result of the research by the present inventors, it became possible to carry out the mass culture and continuous culture of thermophilic cellulose-decomposing bacteria in a semi-permanent manner and to reduce the number of days required to cultivate actinomycetes and filamentous fungi, which made the adhesion of more spores possible. Owing to these, the present invention can use as seeds 42 strains or more of strong microorganisms that are involved in the decomposition and humification of organic matter. ② As the extender-carrier, /251 in addition to limestone powder, the present invention blends and utilizes perlite, vermiculite, zeolite, and any other useful materials that exhibit their specificities in improving the physical and chemical characteristics of the soil or in conditioning the soil environment. ③ The micronutrients known to date that are required by soil microorganisms are added in as many types as possible and in quantities that sufficiently meet the need of the microorganisms.

1. Cultivation of facultative anaerobes or anaerobes, such as thermophilic cellulose-decomposing bacteria, etc.

① Cultivation of thermophilic cellulose-decomposing bacteria

Celluloses are found most widely and in large quantities in nature. They are found plentifully, especially in wood, straw, etc., in which they form cell walls, and they are also contained in almost

all vegetative organic substances. Therefore, the decomposition path that they go through when they are returned to the soil for humification and the function, ecology, and the like of the microorganisms that are involved in the process are some of the most fundamental research topics. What are generally called cellulose-decomposing microbes include such types of microbes as bacteria, actinomycetes, filamentous fungi, etc., but thermophilic bacteria, such as Crostridium thermocellum, Bacillus thermocellulolyticus, Bacillus thermofibrincolus, Bacillus cellulose dissolvens, etc., play an important role in the decomposition and fermentation of organic matter owing to the fact that their cellulose decomposition power is stronger and that they have a broader range of propagation conditions.

For the cultivation of thermophilic cellulose-decomposing bacteria, the Viljoen, Fred, Peterson (1926) medium, which is comprised of 5 g of peptone, calcium carbonate in saturation, 2 g of ammonium sodium hydrogen phosphate, 1 g of potassium dihydrogen phosphate, 0.3 g of magnesium sulfate, 1 g of calcium chloride, ferric chloride in a trace quantity, 15 g of cellulose (filter paper), and 1,000 cc of well water, is used. Part of this medium composition may be replaced by natural substances. The cultivation is conducted at 60 ± 5° C under anaerobic or facultative anaerobic conditions for 48 to 60 hours.

② Cultivation of hemicellulose-decomposing bacteria

Hemicelluloses form plants (cell walls) together with celluloses, but they are differentiated from celluloses by their characteristics of, for example, readily dissolving in a dilute base and [illegible] dilute acid. When hydrolyzed, they produce their constituent succharides, such as xylose, arabitose, glucose, mannose, galactose, etc. According to which of these components they contain, hemicelluloses are called xylan, araban, dextran, mannan, and galactan.

Of these, xylan is a carbohydrate that is present in nature widely and in large quantities, next after celluloses and starches, and it is found especially in straw, wood, seed coats, etc., in large quantities.

For the cultivation of hemicellulose-decomposing bacteria, an Iwata's medium (1936) in which rice straw xylan is dissolved at a concentration of about 1 % is used. The Inata's medium is comprised of 1 g of ammonium dihydrogen phosphate, 0.2 g of potassium chloride, 0.2 g of magnesium sulfate crystals, 40 cc of a 0.1 N sodium hydroxide solution, and 960 cc of well water, and its pH is 6.8 to 7.0. The bacteria are mass-cultured at 35 ± 5° C under facultative anaerobic conditions.

③ Cultivation of pectinaceous substance-decomposing bacteria

Substances, including hydropectin as well as those ranging from protopectin to low molecular pectic acid, that mainly consist of D-

galacturonic acids that are linked in a chain shape are together called pectic substances, and they are contained in stems and leaves, potatoes, fruits, etc., in large quantities.

Bacteria that actively decompose pectin often belong to the Bacillus subtilis group or ethanol-acetone bacteria if they are aerobic, and to butyric acid bacteria if they are anaerobic. According to the present invention, a medium prepared according to the Molish's formula (1939), which is comprised of 0.5 g of pectin (extracted from lemon or carrot), 0.05 g of potassium dihydrogen phosphate, 0.05 g of ammonia sulfate, 0.2 g of calcium carbonate, and 100 cc of tap water, is used, and the cultivation is carried out at 35 ± 5° C.

④ Cultivation of purple non-sulfur bacteria

Photosynthetic bacteria are classified into three families: purple sulfur bacteria, green sulfur bacteria, and purple non-sulfur bacteria, each family further being divided into 13 genera, 6 genera, /252 and 2 genera, respectively. The bacteria that are mainly employed in the present invention are purple non-sulfur bacteria, and the present invention actively utilizes the excellent characteristics of these bacteria, that is, the ability to assimilate by preference low molecular organic acid, amino acid, alcohol, etc., that are generated by the decomposition of organic matter, the ability to decompose hydrogen sulfide, and the ability to fix the nitrogen in the air, and so forth.

For the cultivation of purple non-sulfur bacteria, a Hutner's medium (1046) is used as the base medium. This medium is prepared by dissolving the following ingredients in distilled water: K_2HPO_4 : 0.05 (%), KH_2PO_4 : 0.05 (%), $(NH_4)_2HPO_4$: 0.08 (illegible), $MgSO_4$: 0.02 (illegible), lactic acid : 0.3 (illegible), butyric acid : 0.1 (illegible), citric acid : 0.1 (illegible), Fe : 200 (r % [sic]), C [illegible] : 500 (illegible), B : 5 (illegible), Cu : 1 (illegible), Mn : 100 (illegible), Zn : 200 (illegible), Ga : 1 (illegible), Co : 1 (illegible), and Mo : 5 (illegible), and then by adding 13.7 μg of biotin and 600 mg of yeast autolysate to 1000 cc of the solution, followed by the adjustment of pH to 6.8 to 8.5.

Depending on the situation, part of the ingredients may be replaced by natural products. The culture is conducted at 25 ± 7° C for 48 to 72 hours under aerobic or anaerobic conditions with bright or dark lighting.

⑤ Mass production of the aforesaid facultative anaerobic or anaerobic bacteria

Although natural products may replace part of the above ingredients in some cases, the mediums used here should be those for isolation or mass culture use for each type of bacteria. For thermophilic cellulose-decomposing bacteria, a single-stage continuous fermentation method is employed, while a multistage circulation-type continuous fermentation method is used for hemicellulose-decomposing

bacteria, pectinaceous substance-decomposing bacteria, and purple non-sulfur bacteria, thus mass culturing 800 to 1,000 L/day under facultative anaerobic or anaerobic conditions.

2. Cultivation of aerobic bacteria, such as actinomycetes

① Cultivation of actinomycetes

Actinomycetaies [sic] are widely present in nature, and, especially in soil, they are found in many types and in large numbers. Of these, those that belong to aerobic, mesophilic, heterotrophic, saprophytic, and neutrophilic groups make up the major portion.

It is difficult to generalize their functions in the soil. Together with other microorganisms, they play an important role in decomposing various kinds of organic matter, especially hard-to-decompose celluloses, lignin, etc., so as to produce humus, which is the basis of soil fertilization, and it is believed that they also have an important function in microflora control through the production of antibiotic substances.

For the cultivation of actinomycetes, a Waksman's medium (1919) is used, which is comprised of 30 g of sucrose, 2 g of sodium nitrate, 1 g of dipotassium hydrogen phosphate, 0.5 g of magnesium sulfate ($MgSO_4$ $7H_2O$), 0.5 g of potassium chloride, 0.01 g of ferrous sulfate ($FeSO_4$ $7H_2O$) and 1,000 cc of water and whose pH is adjusted to 7.0, and strong bacteria are collected [illegible] from the soil or composts.

② Cultivation of filamentous fungi and yeast fungi

For the sake of convenience or for practical purposes, these are broadly classified into soil fungi molds and soil yeasts, but they both belong to Eumycetes according to systematic biology. All of them are organotrophs (heterotrophs) and use organic matter as the carbon source.

The place where these filamentous fungi are found most often is the soil, as is the case with bacteria and actinomycetes, and the filamentous fungi in the soil are, of course, found more in cultivated lands in which there are plant roots. Especially in a rhizosphere, they become more active. They participate in the decomposition of organic matter, such as plant remains, etc., and is related to the degree of soil fertility. It is believed that filamentous fungi mainly function at the initial stage of decomposition, and they are then succeeded by bacteria and actinomycetes.

Not much is known about the function of yeast fungi in the soil, but a considerable number of yeast fungi is present in the soil, and, in relation to the trace growth factors that they possess, the coexistence and [illegible] with other microorganisms, soil activities, etc., still remain to be elucidated by future research.

For the cultivation of filamentous fungi and yeast fungi, a Czapek of Dox (1910) medium is used, which is composed of 2 g of sodium nitrate, 1 g of dipotassium hydrogen phosphate, 0.5 g of

potassium chloride, 0.5 g of magnesium sulfate (($MgSO_4$ $7H_2O$), 0.01 g of ferrous sulfate ($FeSO_4$ $7H_2O$), 30 g (as appropriate) of sucrose, and 1,000 cc distilled water, and 15 g of agar is added to a solid [illegible] medium. The genera Mucorales, Aspergilli, Penicillia, Trichoderma, etc., as the filamentous fungi and the genera Hansenula, Torulospsis, Pichia, Endomycopsis, Saccharomyces, etc., as the yeast fungi are isolated from soil or compost and cultured. /253

③ Cultivation of heterotrophic bacteria (putrefactive bacteria)

As is the case with the decomposition of saccharides, to decompose proteins to convert them into ammonia is not a property specific to certain microbes but common to microbes in general. The present invention utilizes microbes belonging to the Basillus subtilis group. Numerous microbes that are generally aerobic and have spores that are highly resistant especially against heating and that are found most widely in nature, including in soil, are named generically Basillus subtilis group microbes.

The cultivation of Basillus subtilis group microbes is carried out aerobically with the use of a Waksman's (1922) medium, which consists of 1 g of grape sugar, 0.5 g of dipotassium hydrogen phosphate, 0.2 g of magnesium sulfate ($MgSO_4$ $7H_2O$), a trace quantity of ferric sulfate [$Fe_2(SO_4)_3$ $9H_2O$], 0.25 g of egg white (powder), and 1,000 cc of distilled water and whose pH is 7.2.

④ Mass production of the aforesaid types of aerobes

After a stock solution is formulated and sterilized, the aforesaid types of aerobes that have undergone isolation or mass culture are individually inoculated and undergo submerged culture or shake culture under a highly aerated condition. A single-stage continuous fermentation method at a rate of 300 to 500 L/day is employed.

With respect to actinomycetes and filamentous fungi, their culture solutions are formed into a 1/3 to 1/10 dilution, to which nutrients are then added, and sprayed over a lightweight porous carrier, such as perlite, vermiculite, etc., and mixed well. Subsequently, cultivation according to the large-size Petri dish stack method or deposition-type batchwise method is conducted. The cultivation is carried out at a rate of 3,000 to 5,000 kg/day for 72 to 85 hours by automatically adjusting aeration, temperature, humidity, etc., to the optimal conditions for the propagation of the microbes and for spore adhesion.

The blending ratio here is generally 25 to 45 (weight ratio) to 100 of the extender-carrier, and the appropriate quantity is determined through experiments based on its kind, especially its water absorbency.

3. Addition of special organic nitrogen sources, vitamins, and trace growth factors

In high quality cultivated lands, regardless of paddy fields or dry fields, there is an astounding number of microbes on the order of 10^7 to 10^9 /g. Of those, less than 15 % can grow with succharides and inorganic salts alone. The majority of microbes require amino acids, vitamins, and trace growth factors, such as VGFs (unknown growth factors), etc., in some form or another. Thermophilic cellulose-decomposing bacteria and purple non-sulfur bacteria are no exception to this. If these requirements are lacking, the continuous cultivation of thermophilic cellulose-decomposing bacteria becomes impossible, and purple non-sulfur bacteria stop propagating and start abnormal fermentation.

Thus, the former trace growth factor is named VGF-α, and the latter, VGF-β (also called groster [as transliterated]). These were newly discovered by the present inventors, and VGF-α in a quantity of 40 ppm or more and VGF-β in a quantity of 0.5 ppm or more are used for the culture of each type of microbe.

Due to the reasons described in the foregoing, the following trace nutrients are also added to the soil activator of the present invention for the benefit of common soil active microorganisms.

Vitamin B_1 (thiamin)	1.00 ppm or more
Vitamin B_2 (riboflavin)	5.00 ppm

Nicotinic acid	800 ppm
Vitamin B_6 (pyridoxine)	0.40 ppm
Pantothenic acid	400 ppm
Folic acid	0.20 ppm
Choline	1[illegible]00 ppm
Biotin	0.20 ppm
Vitamin B_{12} (cobalamin)	0.05 ppm
Paraamino benzoic acid	500 ppm
Corn steep liquor (CSL)	0.01 % or more
Hydrochloric-acid-hydrolyzed defatted soybeans	0.05 % or more

4. Preparation of extender-carrier /254

Because the active microbes to be disseminated into fields here are in extremely small quantities compared to that of the soil, it is extremely difficult to disseminate them uniformly. For this reason, extender-carriers are necessary.

As the extender-carriers, in addition to limestone powder (dolomite powder), are employed perlite, vermiculite, zeolite, diatom earth, bauxite, and the like, which are materials that are characterized by their ability to improve the physical and chemical or biological functions of the soil or to condition the soil environment.

Focusing attention on the lightweight, porosity, and water absorbency, etc., of perlite, vermiculite, zeolite, etc., part of them

is also utilized for the aerobic culture in the propagation and spore adhesion of filamentous fungi and actinomycetes. Since this kind of inorganic material undergoes baking at about 1000° C or a strong chemical treatment, it is regarded as germ-free from the practical point of view, and there is no possibility of other harmful microbes' and weed seeds' being mixed in it.

The following presents a table of components of major extender-carriers and describes their characteristics.

TABLE OF COMPONENTS OF MAJOR EXTENDER-CARRIERS

Items		Perlite	Vermiculite	Zeolite (synthetic)	Diatom Earth
Silicic acid	SiO_2	74.55	44.06	45.94	92.16
Iron	Fe_2O_3	0.71	15.26	1.67	0.94
Alumina	Al_2O_3	15.43	15.52	27.33	2.01
Lime	CaO	0.48	2.03	0.33	0.46
Magnesia	MgO	0.92	6.61	0.79	0.94
Phosphoric acid	P_2O_5	0.25	0.07	0.11	0.07
Soda	Na_2O	2.05	0.16	10.49	0.17
Potash	K_2O	4.41	3.82	0.15	0.61

Items		Basalt powder	Olivine basalt powder	Limestone powder
Silicic acid	SiO_2	51.05	46.90	0.10
Iron	Fe_2O_3	6.42	4.32	0.02
Alumina	Al_2O_3	13.61	11.46	0.02
Lime	CaO	10.07	9.02	54.40
Magnesia	MgO	5.63	14.47	2.90
Phosphoric acid	P_2O_5	0.50	0.17	0.04
Soda	Na_2O	2.05	1.83	0.05
Potash	K_2O	1.50	1.02	0.43

(1) Perlite

This is obtained by baking obsidian, perlite, pitchstone, or [illegible] rocks of these at a temperature of about 1000° C so as to

make them porous, and it is snow-white particles that are extremely light, having a bulk density of 0.4 to 0.6. In addition, its water absorbency is extremely high, and it absorbs a large quantity of a culture medium at a rate of 350 to 400 % in terms of weight, thus providing an excellent habitat for aerobic bacteria.

Even when it absorbs water, it does not [illegible] from softening, and, when mixed in the soil, its actions are not prevented by clay particles that adhere to its surface. It always maintains the maximum air permeability and improves the physical property of the soil into which it is mixed.

Perlite has an acidity of from pH 7.0 to 7.5, and, with the combined effect of the aforesaid air permeability, it promotes the propagation of microbes after absorption and also alleviates the soil's acidity. Another important point is that, since perlite consists of a countless number of closed air cells, it exhibits an excellent heat insulation effect and thus prevents extreme temperature changes in the soil and sudden evaporation of water, which in turn improves the micro-climate of the plant rhizosphere and promotes propagation of soil microorganisms and normal growth of cultivated plants. Since perlite is lightweight, odorless, and nonflammable, it can be safely and conveniently stored, transported, and handled.

(2) Vermiculite

Riddled vermiculite that is dried and then baked at about 1000° C is commonly called vermiculite.

The table presented in the foregoing shows one example of it, and, like perlite, vermiculite proper contains potassium in large quantity. Another noteworthy characteristic is that the porosity of vermiculite is high. Accordingly, it has good water absorbency and water-holding capacity and also passes wastewater and air well, and, when it is applied to the soil, the soil develops a good crumb structure, thus providing habitats for highly developed microorganisms in great abundance.

Furthermore, since vermiculite has an extremely strong base-exchanging property, it sustains fertilizers well and exhibits excellent ability for controlling excess fertilizers. For example, it exhibits a special effect on the prevention of magnesia deficiency /255
caused by excessive potash. When used for horticultural purposes, it promotes the vigorous rhizogenesis of cultivated plants, and the hair roots enter vermiculite tightly, thus causing less damage when the plants are replanted.

(3) Zeolite

Since it eliminates water as if it were boiling when it is heated, it is also called Fusseki [boiling stone]. Zeolite is classified as hydrous amino silicates of alkaline or alkaline earth metals based on

its chemical composition, and it is defined as the framework silicate group, which has an endlessly expanding three-dimensional network structure. Its general formula is given by (Na_2, K_2, Ca, Ba) [(Al, Si) O_2]$_n$ xH_2O. Its water content is continuously eliminated, and part of it is converted back to water reversibly, and its most important characteristics are the fact that, after it is dewatered by heating, it can be utilized as a porous absorption [illegible] or molecular sieve and the fact that its alkaline and alkaline earth metals have high exchangeability.

In spite of the fact that zeolite is produced widely in nature, when viewed from industrial applications, the use as zeolite "molecular sieves" manufactured by the Linde Co. (USA) makes up an overwhelming portion. Natural zeolite comes in various colors but can be made white easily by pulverization. Its major uses are found in paper making, as a filler for plastics, as an additive for detergents, and the like. In addition to the aforesaid characteristics, it has a catalytic effect, etc., and, taking these characteristics as a whole, it is also utilized as a deodorizer in pig farming and chicken farming, a desiccating agent, a wastewater-treating agent, and soil-improving agent.

Incidentally, the component table shows a synthetic zeolite example prepared chemically from a natural product.

(4) Diatom earth

Diatom earth is a soft rock or soil that is composed of fossils of extremely small algae called diatoms that propagated profusely in past geologic ages. Dug raw material soil is sifted, washed with water, and dried, and then it is subjected to pulverization, or to baking after the drying, to produce a product.

The main component of diatom earth is silicate, and its true specific gravity is 2.10 to 2.26, which is not much different from the specific gravity of pure silicate, but, from the structural point of view, since it has air trapped inside the diatom shells, it is highly porous, having a porosity of 80 to 90 %, and very light, with an extremely large apparent specific gravity of 0.22 to 0.28; thus, its physical characteristics are, for example, that it has a large volume per unit weight and that it has especially high liquid absorbency and is capable of absorbing and retaining water in a quantity that is approximately 3 times its weight. Furthermore, from the viewpoint of chemical characteristics, except that it is slightly affected by hydrofluoric acid and concentrated alkali solutions, diatom earth per se is little affected by chemical changes. When diatom earth is blended with powder fertilizers, etc., at a ratio of 3 to 5 %, the fertilizers, etc., have improved fluidity and do not form clumps; thus, it functions as an excellent extender. Furthermore, it has a heat-

retaining property and is useful for improving the micro-climate of plant rhizospheres.

(5) Basalt

Basalt is a general term for basic volcanic rocks, and, when applied in a broader sense, it may also include ultrabasic rocks. The present invention intends to utilize the powder of basic rocks or ultrabasic rocks, such as tholeiite basalt, olivine basalt, olivine, gabbro, etc.

The reason for this is that the present inventors confirmed through experiments that, as shown in the component table, these rocks themselves are rich in magnesium and calcium, and the hydrogen ion concentration increases as they become finer grains; thus, their pH readily reaches the range of 11.6 to 12.0, which fact makes them useful for the improvement of acidic soil. Since these rock powders are readily obtainable from stone pits as waste products in quantities of tens of thousands of tons or more, they are utilized as the extender-carrier of the present invention.

(6) Limestone (Dolomite) powder

As seen in the component table, its main components are calcium and magnesium ions, which elute easily, and it not only becomes a source of nutrition for cultivated plants and soil active microorganisms, including thermophilic cellulose-decomposing bacteria, but also has the functions of adjusting the hydrogen ion concentration

in soil and of building soil crumb structures as well as the functions of making phosphoric acid in the soil available to plants and microorganisms, of releasing non-exchangeable potassium, and of preventing heavy metal damage in areas affected by mine pollution, thus rendering itself useful for creating good environmental conditions. /256

5. Preparation of soil activator

Lastly, one more important function of the extender-carriers is to suppress the water content of the soil activator as a whole to 7 % or less, thus preventing the effects of external temperatures and humidity so as to preserve spores and soil active microorganisms that are in a semidormant state as durable cells for a long period of time without degenerating them.

According to the characteristics of limestone powder and various other kinds of extender-carriers, the utilization method of cultivated land, the physical and chemical properties as well as the degree of biological activity of the soil, the kind of cultivated plants, and so forth, the mixing ratios of other extender-carriers to limestone powder are determined within the range from 5 % to 7 %, and, furthermore, the particle size of each extender-carrier is determined according to the type and [illegible] of spraying equipment. Finally, taking into consideration contamination by harmful microorganisms, deterioration prevention and preservation of seeds as well as

economical efficiency of production control, etc., the form of the soil activator is selected from, for example, powder form, pellet form, pearl form, flake form, etc., based on an overall judgment.

According to the present invention, a product in the determined form is prepared by adding, together with respective mediums, concentrated microbe solutions obtained by mixing anaerobic cultures or facultative anaerobic cultures of major microorganisms that are useful for the decomposition and humification of organic matter in the soil, that is, thermophilic cellulose-decomposing bacterial, hemicellulose-decomposing bacteria, pectinaceous substance-decomposing bacteria, purple non-sulfur bacteria, etc., with natural macromolecular coagulants (charge-transfer substances) that are suitable for these cultures; similarly prepared concentrated microbe solutions of aerobic cultures of yeast fungi and heterotrophic bacteria (putrefactive bacteria); and solid-form aerobic cultures of filamentous fungi and actinomycetes as well as organic nitrogen sources, vitamins, trace growth factors, etc., to extender-carriers that are mainly composed of limestone powder and by stirring and blending the mixture.

The following presents one example raw-material composition.

Composition ratio of the raw materials

(to 1,000.g of limestone powder)

Concentrated bacterial solution of thermophilic cellulose-decomposing bacteria 0.3 g

Concentrated bacterial solution of hemicellulose-decomposing bacteria 0.3 g

Concentrated bacterial solution of pectinaceous substance-decomposing bacteria 0.3 g

Concentrated bacterial solution of purple non-sulfur bacteria 0.5 g

Solid culture of filamentous fungi 50.0 g

Solid culture of actinomycetes 50.0.g

Concentrated microbe solution of yeast fungi 0.7 g

Concentrated microbe solution of heterotrophic bacteria 0.3 g

VGF-α 50.0 mg

VGF-β (also called Groster) 20.0 mg

Lutin 10.0 mg

Vitamin B_1 1.2 mg

Vitamin B_2 5.5 mg

Nicotinic acid 800.0 mg

Vitamin B_6 0.5 mg

Pantothenic acid 400.0 mg

Folic acid 0.3 mg

Choline 15.0 mg

Biotin 0.2 mg

Vitamin B_{12} 0.1 mg

Paraamino benzoic acid 7.0 mg

Corn steep liquor (CSL) 0.5 g

Hydrochloric-acid-hydrolyzed defatted soybean solution

0.7 g

Perlite (for filamentous fungi and actinomycetes culture use) 100.0 g

Diatom earth	30.0 g
Vermiculite	200.0 g
Limestone powder	1,000.0 g

Thus, the following advantages can be listed as the excellent effects of the present invention.

(1) By developing a new aerobic solid mass culture for soil filamentous fungi, actinomycetes, etc., and discovering VGF-α and VGF-β (also called groster), the present inventors made it possible to implement continuous culture of thermophilic cellulose-decomposing bacteria and also to prevent abnormal fermentation of purple non-sulfur bacteria, thus creating a new mass cultivation method for these microbes; as a consequence, they succeeded in the preparation of a soil activator that contained more than 42 strains of seeds that are considered to be the major microbes. Accordingly, when this /257 soil activator [sic] is actively disseminated and propagated, thus artificially increasing its density and maintaining the succession of the soil ecosystem and the balance of microorganism phases, the true humification of organic matter in the soil progresses more reliability at higher speed and also naturally, which makes this invention a highly useful method for "soil preparation" in present Japanese agriculture.

(2) The addition of special organic nitrogen sources, such as corn steep liquor (CSL), hydrochloric-acid-hydrolyzed defatted soybeans, etc., and of trace growth factors, such as vitamins, VGF--α and VGF-β (also called groster), etc., and the inoculation and propagation of yeast fungi and purple non-sulfur bacteria have beneficial effects on the growth of a wide range of soil microorganisms, thus enhancing the advantage described in the aforesaid (1).

(3) The major components of limestone powder are calcium and magnesium ions, and it not only serves as an essential source of nutrition for microorganisms and cultivated plants but, at the same time, also exhibits effects as an indirect fertilizer--for example, it improves the physical and chemical as well as biological functions of the soil or conditions the soil environment, thus promoting the formation of crumb structures and preventing the fixation of phosphoric acid, which leads to the promotion of [illegible] of volcanic ash soil.

(4) Whether an artificial inoculation method of soil active microbes like the method of the present invention succeeds or not depends on whether the conditions in which these microbes establish themselves and become active are created or not. Perlite, vermiculite, etc., which are disseminated as extender-carriers in large quantities together with limestone powder, are lightweight and porous and have

good water drainage and air permeability, and they also have high water absorbency and good water-retaining property. In addition, they have excellent base exchangeability, thus adjusting the hydrogen ion concentration, and promote the formation of crumb structures, thereby creating plenty of habitats for highly developed microorganisms.

(5) Because the extender-carriers of the present invention are inorganic and chemically stable, they are useful for effective cultivation of seeds, and the soil activator that contains numerous spores and durable cells can endure long-term storage without deterioration.

(6) Forming the soil activator of the present invention in a solid form and selecting its form from powder, pellet, pearl, flake, etc., forms facilitate and ensure the storage and dissemination of the soil activator.

In some working examples in which the soil activator of the present invention was applied, the excellent effects of the present invention were further demonstrated.

Working Example 1

"Soil preparation " can be achieved by year after year of application of high-quality fully matured composts. Composts are the best material that has excellent overall effects on "soil preparation." The soil activator of the present invention also exhibits excellent effects on the maturing of composts.

To 1,000 kg of rice straw were added 80 kg of the powder-form soil activator (perlite : vermiculite : limestone powder = 5 : 20 : 100) and water, and the mixture was temporarily piled for 8 to 10 days. Next, ammonium sulfate or urea in a quantity equivalent to 1.2 kg of nitrogen was spread over the pile, and the pile was stamped on lightly while water was sprayed over it. In the middle of the composting process, the pile was turned once. The pile fermented well and finished the composting process in 45 days. The pile had thoroughly decayed, and the color of the pile as a whole changed to a dark reddish color. It was moist and crumbled immediately when pulled. It had a carbon content of 18.2.

Meanwhile, controls were prepared by adding, in the place of the soil activator of the present invention, 80 kg of a mixture comprising perlite, vermiculite, and limestone powder in the ratio of 5 : 20 : 100 or by adding nothing, and these controls were composted along with the pile to which the soil activator of the present invention was applied in entirely the same manner as the pile with the soil activator. As a result, the former control was in a halfway composted state, and the latter was dry and could not be regarded as a compost yet.

The carbon content of the former control was 33.6 and the latter was 39.2.

Working Example 2

This was an application test on a rice paddy.

Test field: Mountainous region of Yokote City in Akita prefecture

The field was about 300 m away from forest land. Every year, /258 cow manure was added to the rice paddy at a rate of 1,100 kg per 10 ares. The soil texture was normal.

Test variety : Kiyonishiki

Test scale : 10 ares per zone

Test conditions : On April 27, 100 kg of the soil activator (vermiculite : limestone powder = 10 : 100) of the present invention was spread to the application zone. Other than this, the following manuring practice was carried out for both application zone and control zone under the same conditions.

Tenpi [as transliterated] : 40 g of rin-ka-an [as transliterated] composite (2, 8, 4), May 6.

Tilling: May 7

Rice planting : May 22

Additional fertilization : Urea was applied four times, 18 kg each time, only to the control group.

Harvesting : October 5.

Root taking and initial growth proceeded well both in the application zone and control zone, showing no difference from other rice paddies. However, once a high-temperature period started in the

latter part of June, the difference between these two zones was clearly discernible. The application zone had little gas generation, and the [illegible], stems, and leaves were all thick and long, and, because of the concern for straight head and lodging, no additional fertilization was carried out for the application zone. In spite of this, the plants divided and grew strong, and the ear emergence was 5 to 6 days earlier, showing no lodging.

The test result was that, when harvested on October 14 [sic], the net yield of the application zone was 776 kg, and that of the control zone was 639 kg. Thus, the application zone had about a 21 % yield increase.

Working Example 3

The following was an application test on greenhouse culture in Miyazaki prefecture.

(1) Tomatoes

Land that experienced bacteria wilt and root rot a year before was selected for the test. Prior to furrowing, the pellet-form soil activator of the present invention that was mixed with a base fertilizer, which was an organic fertilizer (about a three-month-old pile mainly comprised of wild grass, fallen leaves, etc.), and with a compound manure was applied in a quantity of 100 kg per 10 ares. Sterilization and other manuring practice were carried out as usual.

Bacteria wilt and root rot, which occurred the previous year, did not occur at all.

The fruits were fresh and had a good color, and the yield increased 4 % or more, thus proving that the soil activator of the present invention makes continuous cropping possible.

(2) Cucumbers

The application was carried out in the same manner as with tomatoes. Cucumbers grew wonderfully, having no disease occurrence. The cucumbers were thick, long, and uniform in shape, with no bending. They were also produced in a larger quantity, and the yield increase was 30 % or more. Their quality was also excellent, and they could be sold at a price about 20 % higher than those of other areas.

The material composition of the soil activator applied in this test was vermiculite : limestone powder = 40 : 100.